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Group Inequality and Conflict*

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ABSTRACT

This paper presents a theoretical model to show how distributional concerns can engender social conflict. We have a two period model, where the cost of conflict is endogenous in the sense that parties involved have full control over the level of conflict they can create. Our analysis highlights the crucial role of future inequality. It is shown, equality of assets or income in the current period does not stop conflict from taking place if the anticipated future inequality is significant. Further we find that the impact of inequality on conflict is not straightforward. Since conflict is costly for both groups, societies with low levels of inequality show no conflict; groups engage in conflict only when inequality exceeds a certain threshold level. Additionally the model shows that the link between inequality and conflict may be non-monotonic.

Keywords: Conflict, group inequality; Nash Bargaining

JEL Classifications: C78, D31, D74

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1 Introduction

This paper presents a simple model showing how distributional concerns can engender social conflict. We focus on the phenomena of intra-state conflict that has become common in recent years (Stewart et al. 2001). It is usually manifested in terms of widescale demonstrations, protests, strikes and sometimes violent rebellions, leading to severe disruption of economic activity.¹ This can weaken a country's institutions and severely impede its economic progress. In fact, many of the states in the poorest regions of the world have gone through serious intra-state conflict in the recent past. While it may be plausible that conflict may exacerbate the existing levels of poverty and inequality, a number of studies have demonstrated the opposite. MacCullough (2001) after controlling for several factors such as income, military expenditure and country and time specific effects, observed that higher inequality can lead to higher conflict. Nafziger and Auvinen (2000) using an improved inequality data set and a broader definition of conflict find a strong link between inequality and war. Other studies such as Alesina and Perrotti (1996), Cramer (2003) and World Bank (2003), point to economic inequality as an important cause of conflict.²

In this paper, we provide a theoretical framework to analyze the link between inequality and conflict. In particular our emphasis is on wealth inequality and conflict. In mainly agrarian economies, for example, land inequality closely reflects wealth inequality and the distribution of land can be a source of discontent. In Central American countries, such as El Salvador and Guatemala, strong reliance on agro based exports led to an extremely disproportionate amount of land in the hands of a few rich and powerful interests. This resulted in serious conflict with those who have been dispossessed (Brockett 1988). In a recent study Macours (2011) finds that the growing inequality between the landed and landless fueled the Maoist movement in Nepal. But inequality in assets is not just limited to land inequality. One of the important reasons for conflict in Angola and the D.R. Congo was for the control of the natural resources.³ The share (or the lack of share) of the different groups in these resources can be seen as the source of asset inequality.

The emphasis on asset based inequality does not in any way reduce the importance of other factors, historical, ethnic or religious, in creating conflict. In fact our analysis presumes the polarization of a society into rival groups.⁴ How these groups are formed and the ensuing tensions between them are an essential part of any description of conflict. We take these group formations as given.⁵ In essence, therefore, this paper models the impact of group inequality (or horizontal inequality) on conflict. There is a growing body of evidence which implies that more than inequality among households (or individuals), what matters for conflict is the inequality among groups. The groups here are broadly defined and presumes a fractionalization along ethnic, religious or economic class lines.

Using national surveys for 55 developing countries, Ostby (2007, 2008) finds strong evidence that countries with high levels of systematic between group inequalities in terms of households assets and

¹We do not distinguish between violent and non-violent conflict here. See Nafziger et al. (2000) and Sachs (1989).

²Collier and Hoeffler (2000) do not find any significant impact of inequality on conflict. However, for the problems with their paper refer to Cramer (2003) and Nafziger and Auvinen (2002, p.156).

³'Q&A: D R Congo Conflict', B.B.C News, December 15, 2004 and 'Country Profile: Angola', B.B.C News, May 3, 2005. Available at <http://news.bbc.co.uk>.

⁴Esteban and Ray (1999) discuss how the distribution of the population across different groups effect conflict. They find that conflict is the highest under a symmetric bimodal distribution, i.e. when the society is polarized. Empirical evidence of polarization (based on ethnic lines) leading to conflict has been reported by Matlova and Reynal-Querol (2005).

⁵For the dynamics of group formations see Garfinkle (2004a, 2004b).

education does have a higher probability of an outbreak of civil war. More detailed case studies have also established the importance of group inequality in fostering conflict (Nafziger et al. 2000; Stewart 2001). In a recent paper using a rich cross-country data set and a better indicator of group inequality Cederman et al. (2011) finds a strong link between group inequality and conflict.

To demonstrate how group inequality and conflict are interlinked, we use a two-period game framework which is similar to Garfinkel and Skaperdas (2000) and Skaperdas and Syropoulos (1996).⁶ However, unlike those models, the groups here directly choose the level of conflict, rather than choosing between productive and defensive activities.⁷ Another difference with the previous papers lie in how the joint output is distributed. In standard choice theoretic models, the share of each group depends on the amount of resources the groups invest in enhancing their relative capability to capture a larger share of the output. In contrast, we presume an underlying social contract between the groups when it comes to the distribution of joint outputs. This contract may be arrived at through some bargaining process between the groups. In this sense our model is closer to Banerjee and Duflo (2003) and Rodrik (1998). The shares of the groups, in our model, depend on the relative levels of wealth. If a group is relatively wealthy, then presumably it can have more leverage in the bargaining and thus be able to appropriate a larger share of the output. The current level of group wealth inequality is then reflected in a more skewed distribution of income between the groups in the future. Whilst Skaperdas and Syropoulos (1997) discuss distributional issues in the context of conflict, it is in a static framework. Also, unlike their model, ours does not allow conflict in the absence of inequality.⁸ In addition, one of the features of their model is that groups with higher appropriative capabilities enjoy a larger share of the output. By specifying a stable social contract through the distribution rule, our model refrains from such an anarchic situation.

Yet we are able to demonstrate how future group wealth (asset) inequality can tip a peaceful society into conflict. Since higher inequality leads to a more skewed distribution of the joint output, beyond a certain level of inequality the costs of engaging in conflict are less than the benefits of a higher share of the output resulting from the conflict. We proceed to show that even if wealth and income were equally shared, conflict may still arise, so long as there is a possibility of future inequality. This is similar to Skaperdas and Syropoulos (1996) who find that “a longer shadow of the future can in fact harm cooperation and intensify conflict”. Taking the analysis further, we argue that conflict just does not simply increase with inequality and the disadvantaged groups are not the only ones to engage in conflict. At higher levels of inequality both the advantaged and the disadvantaged groups may engage in conflict which is what we often see when repressive measures are undertaken by the advantaged group (and in many cases by governments aligned to the advantaged group) to suppress the conflict initiated by the disadvantaged group. We also find that as inequality rises the potential increase in conflict may be high enough to act as a disincentive for groups to participate in production processes, the sharing of the output of which is the main source of conflict. We show that the link between inequality and conflict is non-monotonic.⁹

⁶We, therefore, broadly follow the choice theoretic approach. For other approaches to modelling conflict and inequality see Benabou (1996) and Somanathan (2002) among others.

⁷Addison et al.(2003) and Benhabib and Rustichini (1996) also take a similar approach as ours.

⁸In a similar context, Benhabib and Rustichini (1996) present a dynamic model, but they also allow for conflict under perfect equality. Further, unlike ours, the groups in their paper do not incur any cost in the current period to initiate conflict.

⁹In a similar vein Milante (2004) also finds a non-monotonic relation between wealth inequality and conflict. However, the structure of his model and the general result differ significantly from ours.

The plan of the paper is as follows. In the next section, we describe the basic structure of the model used in the paper including the production technology, the consumption decisions made by the groups, the social contract and the stages of the game between the groups. In Section 3, we analyze in detail how future group inequality and current levels of conflict may be related. The following Section discusses some extensions of the model and Section 5 concludes the paper with some discussion about the policy implications of our results. For the rest of the paper, inequality will imply wealth inequality between groups.

2 Model: Basic Framework

Consider two groups, i and j , involved in the production of output over time periods, $t = \{1, 2\}$. The groups are endowed with one unit of indivisible human capital each period. They can produce the output jointly or fall back on their own production. If they decide for joint production, then their share of the joint output in each period is determined by a rule based on their wealth in that period w_t^i and w_t^j . We assume that there is no wealth inequality to begin with. Thus $w_1^i = w_1^j = w^0$.

2.1 Production

For the joint production case, we assume that the groups divide an exogenously given level of output say R_t in each period. Further, $R_{t+1} \geq R_t$, that is in each period the joint production is at least as large as the previous period. Let $h_t^m \in \{0, 1\}$ represent the level of human capital used for joint production by any group $m = i, j$. The joint output is given by

$$Y_t = R_t h_t^i h_t^j. \quad (1)$$

When either $h_t^i = 0$ or $h_t^j = 0$, $Y_t = 0$. If joint output is produced, it is equal to R_t .

Output under own production for group m is

$$Y_t^m = w_t^m (1 - h_t^m). \quad (2)$$

Thus when effort in joint production $h_t^m = 0$, own output for group m will be w_t^m . On the other hand if $h_t^m = 1$, $Y_t^m = 0$.

We assume that the joint output is far greater than the combined total of each group's own production, that is $R_t \gg w_t^i + w_t^j$. Wealth levels do not effect the joint output, but it does effect the level of own production.¹⁰ Both groups receive a part of the joint output according to some distribution rule, which is discussed next.

2.2 Social Contract

Social contract or the sharing rule is of crucial importance in any conflict model. This paper will not be an exception in that regard. In the literature, the exogenous distribution rules (known as 'contest

¹⁰Here we have assumed that wealth is used for own production. However, another interpretation is possible where wealth is used to buy some insurance against the possibility that the alternative of joint production may not be realised. Under this interpretation, the amount of output received in case of the failure of joint production is equivalent to the level of initial wealth.

success functions') are represented by proportional sharing rules, with an emphasis on a winner-takes-all feature.¹¹ This type of sharing rules is appropriate in analyzing situations of war, where there is an element that the victor commands all the resources. However, most conflict that we see today is intra-state conflict, be it peaceful protests or civil war. For such cases the winner-takes-all feature may not be appropriate, since the loser may still be receiving some share of the resources, albeit a very small one. This feature is particularly desirable for conflict situations and not all distribution rules share that property (Hirshleifer 1989).

In our model, similar to Banerjee and Duflo (2003), we propose an exogenous sharing rule for the joint output based on the fact that if either of the groups decides not to take part in the joint production, their fall back option is their own production. Keeping this aspect in mind, we propose the 'split-the-difference' sharing rule,

$$d_t^i = Y_t^i + (1/2)(Y_t - Y_t^i - Y_t^j), \quad (3)$$

$$d_t^j = Y_t^j + (1/2)(Y_t - Y_t^i - Y_t^j), \quad (4)$$

where i and j 's share of the joint output, given by d_t^i and d_t^j , depends on the difference in the outputs from own production between the two groups (which in turn depends on the wealth levels).¹² Equal levels of wealth will result in an equal distribution of the pie. We would assume that the share of the joint output that each group receives is greater than their respective level of own production, that is, $d_t^i > Y_t^i$ and $d_t^j > Y_t^j$ for $t = 1, 2$, which would incline the groups towards joint production. Note that both groups have equal bargaining power under this sharing rule, but more general rules can be used.

2.3 Conflict

While both the groups have some control over the production aspect (in the sense that they can choose between joint and own production), they have little control over the sharing rule of the joint output. In such a case, if group i is unhappy with its share of the joint output, d_t^i , it can resort to conflict. It is important to note that as in Banerjee and Duflo (2003), conflict does not affect the sharing rule. In this model conflict takes the form of destruction of the other group's share of the joint output. There is, however, no direct appropriation of the opponent's share. Our model, therefore, does not discuss looting.¹³ When one group indulges in conflict, it not only harms their opponent, but also adversely effects its own income, albeit not to the same extent.

Let n_t^i and n_t^j represent the level of conflict that groups i and j respectively choose in time t . In particular, n_t^i is the proportion of destruction of group j 's share by group i and similarly n_t^j is the proportion of destruction of group i 's share by group j . The net income of the groups under joint production will be

$$y_t^i = (1 - kn_t^i)(1 - n_t^j)d_t^i, \quad (5)$$

$$y_t^j = (1 - n_t^i)(1 - kn_t^j)d_t^j, \quad (6)$$

¹¹ See Hirshleifer (1991), Skaperdas (1992) and Skaperdas and Syropoulos (1997) among others.

¹² This is the same as the Nash Bargaining Solution with equal bargaining power, which has easy intuitive interpretations and strong axiomatic foundations (Muthoo, 1999). Their own output levels act as the outside options.

¹³ Refer to Azam (2002) for a model that includes looting.

where $k < 1$ reflects limited self damage. For simplicity, the rest of the analysis will assume the proportion of ‘self-damage’ $k = (1/2)$.

Each group, however, has to incur a mobilization cost for engaging in conflict. We model the cost as $((n_t^m)^2 d_t^m / 2)$ where it is increasing in the level of conflict and the group’s share of the joint output, d_t^m . It reflects the intuition that to mobilise, groups may have to sacrifice a part of their joint output. This is evident in many conflicts when groups often sell rights on the contested resources to third parties in return for up-front financial support needed for mobilisation (Ross 2003).

Further, we assume that no group has the ability to destroy each other’s wealth. It is often the case in conflict that wealth or resources of groups are based in territories over which they have exclusive control.¹⁴ Thus it may be that each group’s own wealth are better protected than their respective shares from the joint output. Anbarci et al. (2002) makes a similar assumption where they consider endowments of the groups to be ‘inalienable’. Hence if own production takes place then the net income of each group will be

$$y_t^i = w_t^i \quad \text{and} \quad y_t^j = w_t^j. \quad (7)$$

Under own production, there will be no conflict since it is costly in terms of mobilization and there is no associated benefits as the wealth levels remain unchanged.

The total amount of conflict in period t in the society, denoted by n_t , should involve some aggregation of the level of conflict by both groups. Although different aggregation rules are possible, in this paper we consider the ‘additive’ aggregation rule, where the total conflict is the sum of the level of conflict engaged in by each group.

$$n_t = n_t^i + n_t^j. \quad (8)$$

2.4 Consumption and Savings

Both groups choose a level of consumption (and therefore a certain level of savings) and a level of conflict in each period, to maximize the group’s lifetime utility. Since period 2 is the final period, there will be no savings and hence both groups will consume their total income in that period. The groups, however, have to incur a mobilization cost for engaging in conflict. Similar to Dixit (2004, p. 41) we assume that the utility is linear in consumption and the cost of mobilization increases at an increasing rate with the level of conflict. Thus any group $m = i, j$, would maximize the following,

$$\begin{aligned} V^m(c_1^m, n_1^m, n_2^m) &= V_1^m + \rho V_2^m = c_1^m - \frac{1}{2}(n_1^m)^2 d_1^m + \rho[y_2^m - \frac{1}{2}(n_2^m)^2 d_2^m], \\ \text{s.t. } c_1^m + s_1^m &= y_1^m, \\ c_1^m, n_1^m, n_2^m &\geq 0, \end{aligned} \quad (9)$$

where c_1^m and s_1^m are the level of consumption and savings for group m in period 1 and $\rho < 1$ is the discount factor.

For analytical tractability we will also assume that for both groups savings is proportional to the level of income, i.e. $s_1^m = \alpha y_1^m$ for all $m = i, j$ where $\alpha \leq (1/2)$.¹⁵

¹⁴For instance, FARC rebels controlled vast parts of southern and eastern Columbia (Veillette, 2005). Similarly, LTTE had de-facto ruled northern and eastern Sri Lanka (Stokke, 2006).

¹⁵This is not a very restrictive assumption since similar conditions can be derived from the model without affecting the results. Suppose $r^j \geq r^i$. If an additional constraint $c_t^i \geq \underline{c}$, $c_t^j \geq \underline{c}$ (which reflects a minimum level of consumption) is added to (9) then so long as $\rho r^i \geq 1$ (i.e. marginal future gain from saving outweighs the marginal loss of current

2.5 Inequality

We define wealth inequality, I_t , as the difference in wealth levels in period t ,

$$I_t = \left| w_t^j - w_t^i \right|.$$

Since $w_1^j = w_1^i = w^0$ there is no wealth inequality in the initial period. Thus $I_1 = 0$.

The inequality in period 2, however, will be determined by the difference in w_2^j and w_2^i which in turn are affected by the level of conflict in period 1. The greater the amount of conflict, the lower will be the ‘net income’ of the groups (see (5) and (6)) and hence the lower will be the amount of savings. In other words under joint production savings by each group in period 1 is negatively related to the level of conflict n_1^i and n_1^j . However, if joint production fails, there is no conflict and savings then would be a proportion of the outside option which is w^0 . Thus for all $m = i, j$,

$$w_2^m = \begin{cases} r^m(s_1^m(n_1^i, n_1^j) + w^0) & \text{under joint production} \\ r^m \alpha w^0 & \text{otherwise} \end{cases}.$$

r^m is the interest factor on the gross savings in period t .

To distinguish between pre-conflict and post conflict inequality in period 2, we introduce the concept of anticipated inequality which captures the level of inequality that would exist if there was no conflict. The initial level of future wealth inequality before any conflict will be instrumental in deciding whether the groups want to engage in conflict or not in the first place. Suppose there is no conflict in period 1, i.e. $n_1^i = n_1^j = 0$, then from (5) and (6) we know $y_1^i = y_1^j = (R_1/2)$. Thus savings for both groups in period 1 would be $s_1^i(0, 0) = s_1^j(0, 0) = \alpha(R_1/2)$. The anticipated level of wealth inequality in period 2 when there is no conflict in period 1 is represented as

$$I_2^a = (r^j - r^i)\theta, \text{ where } \theta = \alpha(R_1/2) + w^0. \quad (10)$$

Note that there is heterogeneity in returns to the savings of the two groups. This will be the crucial element which will drive the conflict in this paper. As in Saint Paul and Verdier (1997) this difference in the rate of returns could be thought of as arising out of differential access to capital markets.

For rest of the paper we will assume, without loss of generality, that group j is the fortunate (or the advantaged) group and group i is the unfortunate (or the disadvantaged) group, i.e. $r^j > r^i$. For the sake of simplifying the analysis we normalise the return of the disadvantaged group to $r^i = 1$, which means that the disadvantaged group gets no return on their savings.¹⁶

2.6 The Game

We represent the interaction between the two groups as a game G . Given that the distribution rule is fixed, G is a two period game with each period consisting of the following two stages:

Stage 1: Knowing the distribution, the groups can decide either to produce on their own ($h_t^i = 0$, or $h_t^j = 0$), or to produce jointly ($h_t^i = 1$, and $h_t^j = 1$). It does not make sense to have a situation

consumption), we can show $s_t^i = y_t^i - \underline{c}$ and $s_t^j = y_t^j - \underline{c}$. It can be checked that the results that follow under the assumption $s_t = \alpha y_t$ for both groups, will also go through for this alternative specification.

¹⁶However, this is not a severe restriction. All the analysis below will go through so long as the return the disadvantaged group receives is less than 100%. More precisely, the analysis below will hold for all $r^i \in [1, 2\gamma]$ where $\gamma = \frac{(1-\alpha)}{\rho \cdot \alpha} > 1$.

where one group goes for joint production and the other group goes for own production. Thus we rule out such situations.

Stage 2: If they decide to produce jointly, then each party decides on the level of conflict, that is, $(n_1^i$ and $n_2^i)$ for group i and $(n_1^j$ and $n_2^j)$ for group j .

The strategy for each group is to choose in both periods whether to take part in the joint production and the level of conflict. Let (n_t^{i*}, n_t^{j*}) represent the equilibrium level of conflict and h_t^{i*} , and h_t^{j*} represent the equilibrium human capital input of group i and j respectively for the joint output.

Definition 1 *A subgame perfect equilibrium is given by the quadruplet $(n_t^{i*}, n_t^{j*}, h_t^{i*}(n_t^{i*}, n_t^{j*}), h_t^{j*}(n_t^{i*}, n_t^{j*}))$, $t = 1, 2$ such that each player's choice is a best response to the other player and satisfies sequential rationality.*

We shall use the backward induction approach to find the subgame perfect equilibrium of the game.¹⁷

3 Future Inequality and Equilibrium Level of Current Conflict

In this section we demonstrate the role of future inequality in engendering conflict and investigate how conflict evolves with the changes in future inequality. We find that under certain restrictions on the parameters, for zero or very low levels of inequality neither group engages in conflict, for higher but still low inequality only the disadvantaged group engages in conflict in equilibrium; however, when levels of inequality are high, both groups engage in the conflict. Later we use these results to uncover the link between inequality and total conflict.

As groups engage in conflict, the realised level of future inequality will differ from the anticipated level of future inequality prior to any conflict. This is because conflict will bring down the level of inequality by reducing the overall level of income and thus savings. Our interest in this section is with the level of future inequality that groups anticipate before they engage in conflict. First we show that in the most general case the groups will not engage in conflict in the final period irrespective of the level of inequality.

Proposition 1 *No group will engage in conflict in the last period.*

Proof. Suppose both groups are engaged in joint production in period 2. Using (5) and (9), for group j , $V_2^j(n_2^i, n_2^j) = \max\{(1 - k \cdot n_2^i) \cdot (1 - n_2^j) \cdot d_2^j - \frac{1}{2} \cdot (n_2^j)^2 \cdot d_2^j\}$. Since any increase in n_2^j will reduce V_2^j , group j will not engage in conflict. The same will hold true for group i . Hence, $n_2^i = n_2^j = 0$. If one of the groups decides to engage in its own production in period 2, then by definition $n_2^i = n_2^j = 0$. ■

As there are no benefits from conflict in the last period, none of the groups engage in conflict. What about conflict in period 1? Consider group i . Given (5), (9) and $c_1^i = (1 - \alpha)y_1^i$, in period 1, group i will choose $0 \leq n_1^i \leq 1$ such that it maximizes the following:

$$V^i = (1 - \alpha)(1 - kn_1^i)(1 - n_1^j)d_1^i - \frac{1}{2}(n_1^i)^2 d_1^i + \rho \frac{1}{2}(R_2 + (s_1^i + w^0) - r^j(s_1^j + w^0))$$

¹⁷We show in the Appendix (Proposition A1) the existence of a pure strategy equilibrium for game G .

where $d_1^i = d_1^j = \frac{R_1}{2}$ and $s_1^i = \alpha y_1^i$, $s_1^j = \alpha y_1^j$. The first order condition for group i will be

$$\frac{\partial V_1^i}{\partial n_1^i} = -(1-\alpha)(1-n_1^j)kd_1^i - n_1^i d_1^i + \frac{\rho\alpha}{2}(r^j(1-kn_1^j)d_1^j - (1-n_1^j)kd_1^i) = 0. \quad (11)$$

Similarly the first order condition for group j will be

$$\frac{\partial V_1^j}{\partial n_1^j} = -(1-\alpha)(1-n_1^i)kd_1^j - n_1^j d_1^j + \frac{\rho\alpha}{2}((1-kn_1^i)d_1^i - r^j(1-n_1^i)kd_1^j) = 0. \quad (12)$$

The best-response functions of each group can be derived from their first order conditions.

Rearranging (11),

$$n_1^i = \frac{\rho\alpha}{2}[r^j(1-kn_1^j) - k(1-n_1^j)] - (1-\alpha)k(1-n_1^j).$$

This can be written as, $n_1^i = A + Bn_1^j$ where $A = \left[\frac{\rho\alpha}{2}\left(\frac{I_2^a}{\theta} + \frac{1}{2} - \gamma\right)\right]$, $B = \left[\frac{\rho\alpha}{2}\left(\gamma - \frac{I_2^a}{2\theta}\right)\right]$ and $\gamma = (1-\alpha)/\rho\alpha > 1$. The best response function for group i is then

$$n_1^i = \begin{cases} 0 & \text{if } A + Bn_1^j \leq 0 \\ A + Bn_1^j & \text{if } 0 < A + Bn_1^j \leq 1 \\ 1 & \text{if } 1 \leq A + Bn_1^j \end{cases}. \quad (13)$$

A represents the amount of conflict group i will engage in when it initiates the conflict and B is the change in n_1^i resulting from a change in n_1^j . Whether $A \leq 0$ and $B \leq 0$, depends on the level of I_2^a .

From (11) it can be deduced that, $I_2^a \leq (2\gamma - 1)\theta/2$ implies $A \leq 0$. Thus, when inequality is lower, the damaging impact of conflict by group i on current consumption is far greater than the positive impact on future consumption that such conflict generates. For higher levels of inequality, the positive impact of increased future consumption dominates.

On the other hand, how n_1^i responds to changes in $n_1^j > 0$ depends on whether $B \leq 0$, and thus whether $2\gamma\theta \leq I_2^a$. For $I_2^a < 2\gamma\theta$, an increase in n_1^j will also increase n_1^i , while for $I_2^a > 2\gamma\theta$ an increase in n_1^j will have an opposite impact on n_1^i . This is because for group i , from (11) it is evident that, when inequality is lower, the marginal benefit of increasing n_1^i in response to an increase in n_1^j on current consumption is greater than the marginal cost on future consumption. As inequality increases the marginal cost in terms of reduced future consumption increases. Thus, beyond a certain level of inequality, group i is better off by reducing n_1^i in response to an increase in n_1^j .

Rearranging (12) we get,

$$n_1^j = \frac{\rho\alpha}{2}[r^i(1-kn_1^i) - r^j k(1-n_1^i)] - (1-\alpha)k(1-n_1^i),$$

which can be written as $n_1^j = C + Dn_1^i$, where $C = \left[\frac{\rho\alpha}{2}\left(\frac{1}{2} - \left(\gamma + \frac{I_2^a}{2\theta}\right)\right)\right] < 0$ and $D = \left[\frac{\rho\alpha}{2}\left(\gamma + \frac{I_2^a}{2\theta}\right)\right] > 0$. Group j 's best response then is

$$n_1^j = \begin{cases} 0 & \text{if } C + Dn_1^i \leq 0 \\ C + Dn_1^i & \text{if } 0 < C + Dn_1^i < 1 \\ 1 & \text{if } 1 \leq C + Dn_1^i \end{cases}. \quad (14)$$

It is useful to start the analysis of conflict and equilibrium with the case where anticipated inequality is at its lowest, that is $I_2^a = 0$. For this special case, from (13) and (14) we can show that $A = C$ and $B = D$. Thus the intercept and gradient of the best response functions are the same for both groups. This leads to the best response functions of the two groups as shown in Figure 1.

Insert Figure 1.

Note that given $0 \leq n_1^i, n_1^j \leq 1$, the intercept term for the best response for group j is $(-C/D)$ and for group i is $(-A/B)$. As is evident from the figure above, the unique intersection of best responses is at the origin. Thus, under joint production in period 1 there will be no conflict.

As inequality rises, A will increase and become positive. Let \underline{I}_2^a be the level of inequality when $A = 0$. With further increase in inequality, A will eventually be greater than $(-C/D)$. Suppose \widehat{I}_2^a is the level of inequality such that $(-C/D) = A$. We show below that with higher inequality, conflict will occur which will reduce the income from the joint output. Thus for both groups the gap between the joint output and own production will narrow. Let \widetilde{I}_2^a reflect the level of inequality where atleast for one of the groups, the payoff from joint production under conflict is the same as the outside option. In the next three sections we use these threshold levels of anticipated inequality I_2^a , $0 < \underline{I}_2^a < \widehat{I}_2^a < \widetilde{I}_2^a$, to show how conflict evolves with increase in inequality. In particular, we discuss three regimes with the following broad features:

- low inequality, where $0 \leq I_2^a \leq \underline{I}_2^a$, leads to joint production with no conflict in equilibrium, as for ;
- medium inequality, where $\underline{I}_2^a < I_2^a \leq \widehat{I}_2^a$, again leads to joint production in equilibrium, but now with positive conflict from the disadvantaged group only;
- high inequality, where $\widehat{I}_2^a < I_2^a$, implies joint production still, but now with both groups engaged in positive conflict if $\widehat{I}_2^a < I_2^a < \widetilde{I}_2^a$, and equilibrium collapses to own production if $\widetilde{I}_2^a \leq I_2^a$.

3.1 Low Inequality and Conflict

When the level of inequality is low, such that $I_2^a \leq \underline{I}_2^a$, none of the groups will engage in conflict. As anticipated inequality increases from 0, best responses change gradually. Most important in this first regime is the fact that the intercept term A of group i , increases and reaches 0 when $I_2^a = (2\gamma - 1)\theta/2 \equiv \underline{I}_2^a$. For between 0 and \underline{I}_2^a , best response for both groups produce the same qualitative outcome as Figure 1, namely zero conflict. Thus the only equilibrium is at the point where $n_1^{i*} = 0$ and $n_1^{j*} = 0$. Therefore, total conflict under low inequality is $n_1^* = n_1^{i*} + n_1^{j*} = 0$.

To see whether the groups will engage in joint or own production, first consider period 1. Since $n_1^{i*} = n_1^{j*} = 0$, the share of each group from the joint output will be $R_1/2$. On the other hand under own production they will get w^0 . Thus the groups will engage in joint production if $R_1 \geq 2w^0$. Since we know that for all t , $R_t \gg w_t^i + w_t^j$, the condition for joint production is thus satisfied for both period 1.

In period 2, from Proposition 1 we know there will be no conflict. Therefore, using (5), (6) and (10) we can show that group i (the disadvantaged group) and j will receive $(R_2 - I_2^a)/2$ and $(R_2 + I_2^a)/2$ respectively. The period 2 wealth of group i and j is respectively w_2^i and w_2^j . Note that the wealth

are also the outside options of the groups. The joint production would be realised if $(R_2 - I_2^a) > 2w_2^i$ and $(R_2 + I_2^a) > 2w_2^j$, which implies $R_2 > w_2^i + w_2^j$. Thus irrespective of the level of savings and conflict in period 1, in period 2 there will always be joint production.

The subgame perfect equilibrium of the game is given by the following proposition:

Proposition 2 *For the level of inequality $I_2^a \leq \underline{I}_2^a = (2\gamma - 1)\theta/2$, the subgame perfect equilibrium is $(n_1^{i*} = 0, n_1^{j*} = 0, h_1^{i*}(n_1^{i*}, n_1^{j*}) = 1, h_1^{j*}(n_1^{i*}, n_1^{j*}) = 1)$ and $(n_2^{i*} = 0, n_2^{j*} = 0, h_2^{i*}(n_2^{i*}, n_2^{j*}) = 1, h_2^{j*}(n_2^{i*}, n_2^{j*}) = 1)$.*

In this case group i , the disadvantaged group, would not initiate conflict since the difference in inequality is not high enough to merit engaging in conflict, a part of the cost of which it has to bear. Since the disadvantaged group does not initiate conflict, the advantaged group does not engage in conflict. Thus in equilibrium there is no conflict and joint production takes place.

The condition $\underline{I}_2^a = (2\gamma - 1)\theta/2$ reflects the fact that if the future is less valuable, for instance when $\rho \rightarrow 0$, then there would be greater tolerance for inequality, since the level of inequality, where no conflict takes place, \underline{I}_2^a , will increase. On the other hand, when $\rho \rightarrow 1$ the groups value the future more, which will result in less tolerance for future inequality since \underline{I}_2^a will decrease.

3.2 Medium Inequality and Conflict

As the level of inequality, I_2^a , increase we move from low inequality to a medium inequality regime where $\underline{I}_2^a < I_2^a \leq \hat{I}_2^a$. We split the discussion of medium inequality into two cases: (a) $\underline{I}_2^a < I_2^a \leq 2\gamma\theta$, and (b) $2\gamma\theta < I_2^a \leq \hat{I}_2^a$.

When $\underline{I}_2^a < I_2^a < 2\gamma\theta$, the best response functions of the groups are shown in Figure 2 below.

Insert Figure 2.

The best response function of group i (13) translates to an intercept A with gradient $(1/B)$ in Figure 2. Given the bounds on the level of inequality, it is easy to establish that $0 < A \leq 1$ and $0 < B < 1$. Similarly, the best response function of group j (14) has intercept $0 < (-C/D) < 1$ where $C < 0$ and gradient $D < 1$. Notice that in the presence of non-negativity constraints on levels of conflict, $C < 0$ implies that the best response function for group j extends to the origin, with a kink at $n_1^i = (-C/D)$. Further, one can show that, given $\gamma > 1$, $(-C/D) > A$.¹⁸

Next consider the case where $2\gamma\theta < I_2^a \leq \hat{I}_2^a$. As noted before, \hat{I}_2^a represents the level of inequality such that $(-C/D) = A$.¹⁹ The implication of $I_2^a > 2\gamma\theta$ is that the slope of the group i 's reaction function now becomes negative. So beyond this point, if the advantaged group engages in conflict, the disadvantaged group will reduce its level of conflict. Figure 3 shows the reaction functions of the two groups in this situation.

Insert Figure 3.

¹⁸Also note that $D < 1 < (1/B)$, i.e. group i 's reaction function is steeper than group j 's. This reflects the fact that group j has more to lose by escalating the conflict and hence would increase its own level of conflict at a lower rate than group i .

¹⁹It is shown in the Appendix (Proposition A2), there exists a level of inequality \hat{I}_2^a such that $(-C/D) = A$. More precisely from $(-C/D) = A$ it can be inferred that \hat{I}_2^a is that level of inequality such that $\lambda_1(\hat{I}_2^a)^2 + \lambda_2\hat{I}_2^a + \lambda_3 = 0$; where $\lambda_1 = 1/2\theta$, $\lambda_2 = [(\rho\alpha(2\gamma + 1) - 4)/4\theta]$ and $\lambda_3 = [(\rho\alpha(0.5 - \gamma) + 1)\gamma - 1]/2$.

From Figures 2 and 3, it becomes clear that in case of the joint production, $(n_1^{i*} = A, n_1^{j*} = 0)$ is the equilibrium level of conflict. Group j , the advantaged group, does not engage in conflict. The intuition is simple; $(-C/D)$ reflects the level of conflict engaged by group i that will be tolerated by group j . Hence, so long as the level of conflict (which is group i 's intercept term A) is less than $(-C/D)$, group j shall not engage in conflict.

If there is joint production, the overall level of conflict will be

$$n_1^* = n_1^{i*} + n_1^{j*} = \left[\frac{\rho\alpha}{2} \left(\frac{I_2^a}{\theta} + \frac{1}{2} - \gamma \right) \right]. \quad (15)$$

Differentiating with respect to I_2^a we get $\partial n_1^*/\partial I_2^a = \rho\alpha/2\theta > 0$, i.e. as the level of future inequality increases, overall conflict will also rise.

However, whether both the groups will decide for joint production or not depends on their initial level of wealth. In period 1, the disadvantaged group under joint production in equilibrium will engage in conflict, i.e. $(n_1^{i*} = A, n_1^{j*} = 0)$ and thus from (9) will thus receive $(1 - (A/2))(R_1/2)$. Therefore, the disadvantaged group will participate in joint production if $(1 - (A/2))R_1 > 2w^0$. For the advantaged the condition will be $(1 - A)R_1 > 2w^0$. In the second period, as shown earlier, there is no conflict and both groups engage in joint production since $R_2 > w_2^i + w_2^j$ continues to hold. The equilibrium can be characterized as follows:

Proposition 3 *Given $(2\gamma - 1)\theta/2 < I_2^a \leq \hat{I}_2^a$, and $(1 - A)R_1 > 2w^0$, the subgame perfect equilibrium is $(n_1^{i*} = A, n_1^{j*} = 0, h_1^{i*}(n_1^{i*}, n_1^{j*}) = 1, h_1^{j*}(n_1^{i*}, n_1^{j*}) = 1)$ and $(n_2^{i*} = 0, n_2^{j*} = 0, h_2^{i*}(n_2^{i*}, n_2^{j*}) = 1, h_2^{j*}(n_2^{i*}, n_2^{j*}) = 1)$.*

Here while one of the groups engages in conflict, the other refrains from conflict. This is unlike Benhabib and Rustichini (1996) and Skaperdas and Syropoulos (1997), where both groups always end up engaging in conflict, although only one group might have initiated it.

3.3 High Inequality and Conflict

Now consider the case where $\hat{I}_2^a < I_2^a \leq \bar{I}_2^a$.²⁰ The best response functions for both groups would now be the following:

Insert Figure 4.

If there is joint production, then the equilibrium levels of conflict for both groups (from the best response functions (13) and (14)) are

$$n_1^{i*} = \frac{A + BC}{(1 - BD)}, \quad (16)$$

$$n_1^{j*} = \frac{AD + C}{(1 - BD)}, \quad (17)$$

where $C < 0$ and $B < 0$. Since $(-C/D) < A$ and $B < A$, we can be sure that $n_1^{i*} > 0$ and $n_1^{j*} > 0$. At higher levels of inequality, the level of conflict initiated by group i , is greater than what group j can tolerate, that is, $A > (-C/D)$. Hence group j engages in conflict to counter the conflict initiated

²⁰ \bar{I}_2^a (the maximum level of inequality) is the level of inequality such that $\max(n_1^{i*}, n_1^{j*}) = 1$.

by group i . One can easily check that $0 < n_1^{i*} \leq A \leq 1$ and $0 < n_1^{j*} \leq 1$. The overall level of conflict will be the total of (16) and (17) i.e.

$$n_1^* = n_1^{i*} + n_1^{j*} = \frac{A + (-B)(-C) + AD - (-C)}{1 + (-B)D}.$$

In the Appendix (Proposition A3) we show that $(\partial n_1^* / \partial I_2^a) > 0$. This means that as inequality increases further, the level of conflict also increases. Note, here the disadvantaged group reduces its own level of conflict. Since in this case $(-B) < 1$, the decrease of conflict by the disadvantaged group is more than made up by the increase in the advantaged group's conflict. Therefore, the overall level of conflict increases by more than it would have under the increased level of inequality if the advantaged group did not join in.

On the question of joint or own production under high inequality, it can be shown that when a group reaches \bar{I}_2^a , they prefer own production (see Appendix, Proposition A4). This is because the excessive level of inequality leads to such a high level of conflict thereby reducing the net income of the groups from joint production to such a level that own production becomes a better alternative. Since both groups engage in joint production at \hat{I}_2^a but decide for own production at \bar{I}_2^a , there must exist some $\tilde{I}_2^a \in (\hat{I}_2^a, \bar{I}_2^a)$ such that

$$\min [V_S^i - V_J^i, V_S^j - V_J^j] = 0,$$

where for any group m , V_S^m and V_J^m represents its total benefit from own production and joint production respectively. This condition shows the level of inequality in which at least one of the groups will be indifferent between joint production and own production.

We therefore discuss the possibility of two cases: (a) $\hat{I}_2^a < I_2^a < \tilde{I}_2^a$ and (b) $\tilde{I}_2^a \leq I_2^a \leq \bar{I}_2^a$. As earlier, in both these cases, in the second period there is no conflict and both groups engage in joint production. When $\hat{I}_2^a < I_2^a < \tilde{I}_2^a$ both groups will continue to be in joint production and the equilibrium will be as given next.

Proposition 4 *Given $\hat{I}_2^a < I_2^a < \tilde{I}_2^a$, the subgame perfect equilibrium is $(n_1^{i*} > 0, n_1^{j*} > 0, h_1^{i*}(n_1^{i*}, n_1^{j*}) = 1, h_1^{j*}(n_1^{i*}, n_1^{j*}) = 1)$ and $(n_2^{i*} = 0, n_2^{j*} = 0, h_2^{i*}(n_2^{i*}, n_2^{j*}) = 1, h_2^{j*}(n_2^{i*}, n_2^{j*}) = 1)$.*

Note that with a higher initial wealth w^0 , the inequality \tilde{I}_2^a where the switch from joint production to own production takes place is lowered. Thus for wealthier societies, the inequality interval over which both groups would engage in conflict would be reduced.

When $\tilde{I}_2^a \leq I_2^a \leq \bar{I}_2^a$, clearly either group i or group j drops out of joint production. Since in our model own wealth is indestructible, and conflict is costly, we get the following equilibrium.

Proposition 5 *Given $\tilde{I}_2^a \leq I_2^a \leq \bar{I}_2^a$, the subgame perfect equilibrium is $(n_1^{i*} = 0, n_1^{j*} = 0, h_1^{i*}(n_1^{i*}, n_1^{j*}) = 0, h_1^{j*}(n_1^{i*}, n_1^{j*}) = 0)$ and $(n_2^{i*} = 0, n_2^{j*} = 0, h_2^{i*}(n_2^{i*}, n_2^{j*}) = 1, h_2^{j*}(n_2^{i*}, n_2^{j*}) = 1)$.*

The above proposition shows that under some circumstances there will be no joint production in period 1. Hence, unlike other cases, although ex-ante there is a possibility of conflict, ex-post no conflict will take place.

3.4 Inequality and Total Conflict

So where does all this leave us when it comes to the question about the link between inequality and conflict? As is clear from the above discussion, until \underline{I}_2^a , there will be no conflict, since inequality is low. However, beyond \underline{I}_2^a , we know there is a positive amount of conflict since the disadvantaged group engages in conflict. Conflict now increases steadily with an increase in inequality until \widehat{I}_2^a . Then from \widehat{I}_2^a onwards both groups are engaged in conflict and the overall level of conflict also increases. Now as inequality increases, conflict again steadily rises until it reaches \widetilde{I}_2^a . At \widetilde{I}_2^a , for group i , high levels of conflict make joint production inviable. This is captured in Figure 5 below.

Insert Figure 5.

Therefore one can state the following proposition.

Proposition 6 *The relationship between inequality and conflict is non-monotonic.*

We would like to emphasize that the non-monotonicity in our model results from a sharp change in the level of conflict arising out of groups preferring own production beyond a certain level of inequality. Although Milante (2004) also finds a non-monotonic relationship, unlike ours this is reflected in an inverted-U relationship between inequality and conflict. Hence, in his model, over a certain level of inequality, there is a gradual decrease of conflict as inequality rises.

4 Discussions

In this section we discuss changes to some assumptions so far made in this model and how they impact on the results. In particular we deal with four of the assumptions: (a) the rate of savings are the same for both the groups, (b) the proportion of ‘self damage’ is equal for both groups, (c) that groups have foresight, and (d) the absence of fixed costs.

Rate of savings. Suppose instead of having the same savings rate, consider without loss of generality, that $\alpha^i < \alpha^j$. Further assume that $r^j = r^i = 1$. This would mean that $w_2^i < w_2^j$, and therefore from the distribution rule it would be obvious that $y_2^i < y_2^j$. Group i again is the disadvantaged group. The rest of the analysis will follow through, so long as our inequality now measures the difference between the two savings rates, i.e. $I_2^a = (\alpha^j - \alpha^i)\theta$ where $\theta = R_1/2$. Along with this if we had assumed that $r^j > 1$ the results in the previous sections would only be amplified. However, if $\alpha^i > \alpha^j$ and at the same time $r^j > 1$, the results derived in the earlier sections will now depend on which of these has greater impact. Obviously, since the relative rate of return and the relative rate of savings are going in opposite directions, the results in the earlier sections will be dampened. Since we were interested in understanding the impact of inequality on conflict, distilling all else, we had assumed $\alpha^i = \alpha^j$.

Proportion of ‘self damage’. Thus far we have assumed that the proportion of self damage, k , is the same for all the groups and $k = (1/2)$. As mentioned earlier, for $0 < k < 1$, all the results derived earlier will hold. Here we shall discuss a few cases when k takes extreme values and when the k varies between groups.

First, when $k = 0$ for both groups, the reaction function of group i and j are, respectively, (derived from (13) and (14)) $n_1^i = (\rho\alpha/2)r^j > 0$ and $n_1^j = (\rho\alpha/2) > 0$. Clearly, now both groups will engage

in conflict irrespective of the level of inequality and the level of conflict will depend on the rate of return of the rival group. This is not surprising, since $k > 0$ makes it costly for groups to engage in conflict by reducing both their current and future levels of consumption. The overall level of conflict will be higher now.

Next, let $k = 1$ for both the groups. Recall that the way conflict works in this model is that under high inequality, the disadvantaged group wants to reduce the amount of income devoted to savings by the advantaged group so that, even with a relatively higher return, the advantaged group does not receive a higher level of the output in the future. Now with $k = 1$, this will be extremely costly. Under this assumption, so long as $r^j > 1$, from (13) and (14) the reactions functions of group i and j will be

$$\begin{aligned} n_1^i &= \frac{\rho\alpha}{2w} (I_2^a - 2\gamma\theta) (1 - n_1^j), \\ n_1^j &= -\frac{\rho\alpha}{2w} (I_2^a + 2\gamma\theta) (1 - n_1^i). \end{aligned}$$

Thus, group i , the disadvantaged group will be the only group involved in conflict and that too when $I_2^a > 2\gamma\theta$. Group j , irrespective of the level of inequality and group i 's level of conflict, will not engage in conflict. It is easy to see if the level of self damage of group i is, $k^i = 0$ and of group j is, $k^j = 1$, then the earlier result will be amplified in the sense that now group i will engage in conflict irrespective of the level of inequality and group j will never engage in conflict. On the other hand, if $k^i = 1$ and $k^j = 0$, group j will always engage in conflict and group i will engage in conflict only when inequality is high, i.e. $I_2^a > 2\gamma\theta$. In this situation, unlike the standard results, it will be the advantaged group which will engage in conflict.

Information. Our model assumes that groups have perfect foresight. Hence they can anticipate future inequalities perfectly. This, however, is not very realistic. One way to bring in imperfect information in the model would be to assume that both the groups know the distributions of r^j and r^i . In that case the anticipated future inequality will then be given by $I_2^a = (E(r^j) - E(r^i))w$, where $E(r)$ is the expected rate of return. Thus the conditions under which groups will initiate conflict will remain the same except for inequality being interpreted as expected anticipated future inequality. Hence, all the results that we have discussed earlier will also go through for a case of imperfect foresight. In the event of complete uncertainty, however, the analysis will be more complex and will depend on the group's behaviour. If, for instance, the groups presume that the rates of returns are going to be the same, then obviously there will be no reason for conflict arising from future inequality.

Fixed Cost. In our model both groups have to bear a cost to engage in conflict. Without it, groups would always engage in conflict. We have considered the cost of conflict entering the model in two ways. First, a group engaging in conflict will also inflict some damage to their own share of output and, second, there is a mobilization cost of conflict. In a broad sense both these costs can be classified as variable costs, that is the higher the level of conflict the greater will be these costs. Both groups, however, will also typically incur a set of fixed costs if they decide to engage in conflict. The fixed costs may reflect, among others, the costs involved in forming the groups, and the minimum physical infrastructure that may be needed to run a conflict. Boix et al. (2006) argues that any group engaging in conflict will face both fixed and variable costs. In our model, so far, we have just considered the variable costs. Now suppose that the mobilization of the cost of conflict includes a fixed cost F in addition to the variable cost of $((n_t^m)^2 d_t^m / 2)$ that is considered in the model. Under

such circumstances group i maximises the following

$$\tilde{V}^i = \begin{cases} V^i - F & \text{if } n_1^i > 0 \\ V^i & \text{otherwise} \end{cases}$$

where V^i is based on equation (9). Group j 's objective function will be similarly changed in the presence of fixed costs.

The addition of the fixed costs will not change any of the equilibrium condition, hence the threshold inequality levels at which the groups start engaging in conflict remains unchanged. The level of conflict, however, will increase taking into account the fixed costs. It is clear from Figure 5 above that, until \underline{I}_2^a , there will be no conflict due to low inequality. Beyond \underline{I}_2^a , however, there is a positive amount of conflict by the disadvantaged group. Since to engage in conflict the groups have to incur a fixed cost, we will now find a discontinuous jump in the level of conflict at \underline{I}_2^a . Similarly we will find another discontinuous jump at \hat{I}_2^a , this time due to the advantaged group engaging in conflict. The discontinuity between inequality and conflict will now be at three levels of inequality: \underline{I}_2^a , \hat{I}_2^a and \tilde{I}_2^a . Thus around each of these levels there will be sharp changes in the level of conflict. Hence there may be cases with similar levels of anticipated future inequality but very different levels of conflict.

5 Conclusion

The purpose of the paper was to analyze the interlinkages between group inequality and conflict. In our analysis we find that although inequality may cause conflict, the impact of inequality on conflict is not straightforward. Since conflict is costly for both groups, societies with low levels of inequality, in our model, show no conflict. It is only when inequality increases beyond a threshold, that the disadvantaged group engages in conflict. At higher levels of inequality both groups engage in conflict. Thus, our model is able to capture both rebellion by the disadvantaged group and also suppression by the advantaged group. El Salvador and Guatemala are examples where the state acting on behalf of the advantaged group unleashed severe repression to curb insurgencies. When inequality reaches extreme levels, the economy goes back to subsistence levels as the high output joint production sector is not developed for fear of severe rebellion. For instance, the Bougainville rebellion, arising out of a concern for the local environment and the lack of benefits to the local populace, led to the closure of copper mines, thus leading to a decline in the income of the region.²¹

It is important to note that the traditional sense of 'grievance' is absent in this model since both groups have the same level of income and wealth in the period in which conflict occurs. Groups, however, anticipate future levels of inequality which may precipitate conflict in the current period. Thus our analysis demonstrates the crucial role future inequality plays. Equality in the current period does not stop conflict from taking place today if the future inequality is significant. In Sri Lanka, for instance, only when the government failed to guarantee the rights of Tamils (and also curtailed their access to higher education), did the Tamil insurgency begin in earnest.²² The government policies

²¹See Bougainville-The Long Struggle to Freedom by Moses and Rikha Havini. Available at <http://www.eco-action.org/dt/bvstory.html>. (Accessed August 2010)

²²Sri Lanka had suffered from serious ethno-religious conflict between the Sinhalese majority and the Tamil minority for nearly three decades. For details about the insurgency in Sri Lanka refer to: <http://www.onwar.com/aced/nation/sat/srilank/ftamil1983.html>. (Accessed October 20, 2010)

were seen as a potential source of future inequality where the Tamils would lose out significantly.

This brings us to the policy implications of our results. Since the future plays an important role in fostering conflict, one has to put in place policies that will reduce future inequality. For example, the warring factions in Sudan decided to split future profits from the oil wells equally.²³ If such egalitarian rules can be institutionalized and implemented, then reasons for conflict will definitely diminish. However, typically if one of the groups becomes ‘weaker’ (maybe due to exogenous shocks) in terms of bargaining, the stronger groups tend to capture a higher share of the joint output and that is when the problems start again.²⁴ This may explain why so many peace agreements fail. What is implicit here is that enforceable contracts are not viable and therefore parties cannot forge some kind of ex-ante contract to avoid conflict. If, however, we allow for long-term interaction between the groups, there may be a possibility of overcoming the incomplete contract problem.²⁵ What the structure will be of such long-term contracts under uncertainty is an issue for future research.

²³‘SHRO-CAIRO Position on Sudan Peace Deal and Constitutional Panel’, Sudan Tribune, May 7, 2005. Available at <http://www.sudantribune.com>. (Accessed April 2011)

²⁴In fact the current hostilities in Sudan started after the discovery of oil in the south, which none of the parties were aware of when signing the Addis Ababa peace deal in 1972 (Human Rights Watch, 2003).

²⁵For a very interesting application of contract theory to conflict refer to Azam and Mesnard (2003) .

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A Appendix

First we show the existence of equilibrium in the game G . The proof is constructed using standard arguments found in game theory texts such as Fudenberg and Tirole (1991).

Proposition A.1 *There exists a pure strategy equilibrium in G .*

Proof: First let us start with stage 2 game in period 2. The strategies for groups i and j , $n_t^i \in [0, 1]$ and $n_t^j \in [0, 1]$ are compact for $t = 1, 2$. Since period 1 payoff is already known for group j , and the total income is consumed in the last period, the period 2 payoff, from (9) is,

$$V_2^j(n_2^i, n_2^j) = \begin{cases} \max\{(1 - k.n_2^i).(1 - n_2^j).d_2^m - \frac{1}{2} \cdot (n_2^j)^2 \cdot d_2^j\} & \text{if } h_2^i = 1, h_2^j = 1 \\ w_2^j & \text{otherwise} \end{cases}.$$

$V_2^j(n_2^j)$ is continuous and quasi-concave in n_2^j . Similarly $V_2^i(n_2^i, n_2^j)$ is continuous and quasi-concave in n_2^i . From Theorem 1.2 of Fudenberg and Tirole (1991), we know there exists a pure strategy equilibrium (n_2^{i*}, n_2^{j*}) in stage 2 of period 2. In Stage 1, since $Y_t = 0$, when $h_t^i = 0$ or $h_t^j = 0$, the groups will either both choose own production, i.e. ($h_t^i = 0$ and $h_t^j = 0$), or both will choose joint production i.e. ($h_t^i = 1$ and $h_t^j = 1$). Whether ($h_2^i = 0, h_2^j = 0$) or ($h_2^i = 1, h_2^j = 1$) will depend on (n_2^{i*}, n_2^{j*}) . Therefore the subgame perfect equilibrium would be ($h_2^i = 0, h_2^j = 0, n_2^{i*}, n_2^{j*}$) or ($h_2^i = 1, h_2^j = 1, n_2^{i*}, n_2^{j*}$). Hence, there exists a pure strategy equilibrium in period 2. Let that equilibrium level of payoff for group j in period 2 be V_2^{j*} . Payoff in stage 2 of period 1 for group j can then be written as

$$V^j(n_1^i, n_1^j) = \begin{cases} (1 - \alpha)(1 - kn_1^i)(1 - n_1^j)d_1^i - \frac{1}{2}(n_1^j)^2 \cdot d_1^j + \rho V_2^{j*} & \text{if } h_1^i = 1, h_1^j = 1, \\ w_1^j & \text{otherwise,} \end{cases}$$

which is continuous and quasi-concave in n_1^j . Through similar argument as above we can show $V^i(n_1^i, n_1^j)$ is continuous and quasi-concave in n_1^i . Therefore, from Theorem 1.2 of Fudenberg and Tirole (1991) there exists a pure strategy equilibrium in (n_1^{i*}, n_1^{j*}) stage 2 of period 1. Using similar arguments as earlier, we can deduce that the subgame perfect equilibrium in period 1 would be ($h_1^i = 0, h_1^j = 0, n_1^{i*}, n_1^{j*}$) or ($h_1^i = 1, h_1^j = 1, n_1^{i*}, n_1^{j*}$). Since both periods 1 and 2 have pure strategy equilibriums, the game G will also have a pure strategy equilibrium. \square

Next we formally show the existence of a level of inequality, which clearly demarcates high inequality from medium or low inequality in our model. Referring back to Figure 2, A is the intercept term of group i 's reaction function and $(-C/D)$ is group j 's, both of which are dependent on the level of inequality. We define the lower bound of the high inequality interval as the level of inequality at which $(-C/D) = A$.

Proposition A.2 *There exists a level of inequality, \hat{I}_2 , where $(-C/D) = A$.*

Proof: Let $f = ((-C/D) - A)$. Further,

$$\frac{\partial(-C/D)}{\partial I_2^a} = \frac{\theta}{(2\gamma\theta + I_2^a)^2} \text{ and } \frac{\partial A}{\partial I_2^a} = \frac{\rho\alpha}{2\theta} = \frac{1 - \alpha}{2\gamma\theta}. \quad (\text{A1})$$

Hence,

$$\frac{\partial f}{\partial I_2} = \theta \left[\frac{1}{(2\gamma\theta + I_2^a)^2} - \frac{1 - \alpha}{2\gamma\theta^2} \right] < 0 \text{ for } I_2 \geq 0 \text{ and } 0 < \alpha < (1/2)..$$

We know that for $I_2^a \leq 2\gamma\theta$, $(-C/D) > A$, which implies that at $I_2^a = 2\gamma\theta$, $f > 0$. Now consider the level of inequality $I_2'^a$ such that $A = 1$. At this level $I_2^a > 2\gamma\theta$, and $A = 1 > (-C/D)$ (since $D > (-C)$ for all I_2^a). Hence for $I_2'^a$, $f < 0$. Therefore, by the Intermediate Value Theorem we can find an $\hat{I}_2^a \in (2\gamma\theta, I_2'^a)$ such that at \hat{I}_2^a , $f = 0$, implying $(-C/D) = A$. Further, since $\partial f / \partial I_2^a < 0$ for all $I_2^a \geq 2\gamma\theta$, \hat{I}_2^a will be unique. \square

Third, we demonstrate that under high inequality the total level of conflict will increase with inequality. Recall that in this case the disadvantaged group reduces its level of conflict and the advantaged group increases its level of conflict, with an increase in inequality.

Proposition A.3 *For all $I_2^a > \hat{I}_2^a$, $(\partial n_1 / \partial I_2^a) > 0$.*

Proof: Differentiating both groups' best response functions (i.e. (13) and (14)) with respect to I we get

$$\begin{aligned} \frac{\partial n_1^i}{\partial I_2^a} &= \frac{\partial A}{\partial I_2^a} - \frac{\partial(-B)}{\partial I_2^a} n_1^j - (-B) \frac{\partial n_1^j}{\partial I_2^a}, \\ \frac{\partial n_1^j}{\partial I_2^a} &= -\frac{\partial(-C)}{\partial I_2^a} + \frac{\partial D}{\partial I_2^a} n_1^i + D \frac{\partial n_1^i}{\partial I_2^a}. \end{aligned}$$

Solving these for group i we get

$$(1 + (-B).D) \frac{\partial n_1^i}{\partial I_2^a} = \frac{\partial A}{\partial I_2^a} - \frac{\partial(-B)}{\partial I_2^a} n_1^j + (-B) \frac{\partial(-C)}{\partial I_2^a} + (-B) \frac{\partial D}{\partial I_2^a} n_1^i.$$

Noting that $n_1^j \leq 1$; $\frac{\partial A}{\partial I_2^a} > \frac{\partial(-B)}{\partial I_2^a} > 0$ and $\frac{\partial(-C)}{\partial I_2^a} > 0$; $\frac{\partial D}{\partial I_2^a} > 0$, the above equation implies $\frac{\partial n_1^i}{\partial I_2^a} > 0$. Similarly the result will hold for group j . Since both $\frac{\partial n_1^i}{\partial I_2^a} > 0$ and $\frac{\partial n_1^j}{\partial I_2^a} > 0$, we can conclude $\frac{\partial n_1}{\partial I_2^a} > 0$. \square

Finally, we show that when the inequality level becomes excessive, this would lead to own production instead of joint production.

Proposition A.4 *When inequality is \bar{I}_2^a , groups will choose own production over joint production.*

Proof: For the high inequality case, whether $n_1^{j*} > n_1^{i*}$ or $n_1^{j*} < n_1^{i*}$ depends on parametric specifications. Let us consider the case where $n_1^{i*} > n_1^{j*}$. Since by definition, at \bar{I}_2^a , $\max(n_1^{i*}, n_1^{j*}) = 1$, this implies that at \bar{I}_2^a , $n_1^{i*} = 1$ and from (17), $n_1^{j*} = (\rho\alpha/4)$. Using (5) and (9), group i 's payoff from joint production will then be

$$(1 - \alpha)(1 - \frac{\rho\alpha}{4}) \frac{R_1}{4} - \frac{R_1}{4} + (\rho/2)(R_2 + \alpha(1 - \frac{\rho\alpha}{4}) \frac{R_1}{4} + (1 - r^j)w^0). \quad (\text{A2})$$

On the other hand group i 's payoff under own production will be

$$(1 - \alpha)w^0 + (\rho/2)(R_2 + (1 - r^j)\alpha w^0). \quad (\text{A3})$$

Subtracting (A3) from (A2) and rearranging the terms we get

$$-\left(1 - \left(1 - \frac{\rho\alpha}{4}\right)\left((1 - \alpha) + \frac{\rho\alpha}{2}\right)\right) \frac{R_1}{4} - \left((1 - \alpha) - \frac{\rho\alpha}{2}\right) w^0 - r^j \frac{\rho}{2} (1 - \alpha) w^0 < 0,$$

since, $(1 - \alpha) \geq \alpha > 0$ and $0 < \rho < 1$. Therefore group i will drop out of joint production before inequality reaches \bar{T}_2^a , which would also imply from (1) that group j will also not engage in joint production. Similarly one can also show that when $n_1^{j*} > n_1^{i*}$, and at \bar{T}^a , $n_1^{j*} = 1$, group j will prefer own production to joint production and therefore group i will also not engage in joint production. \square

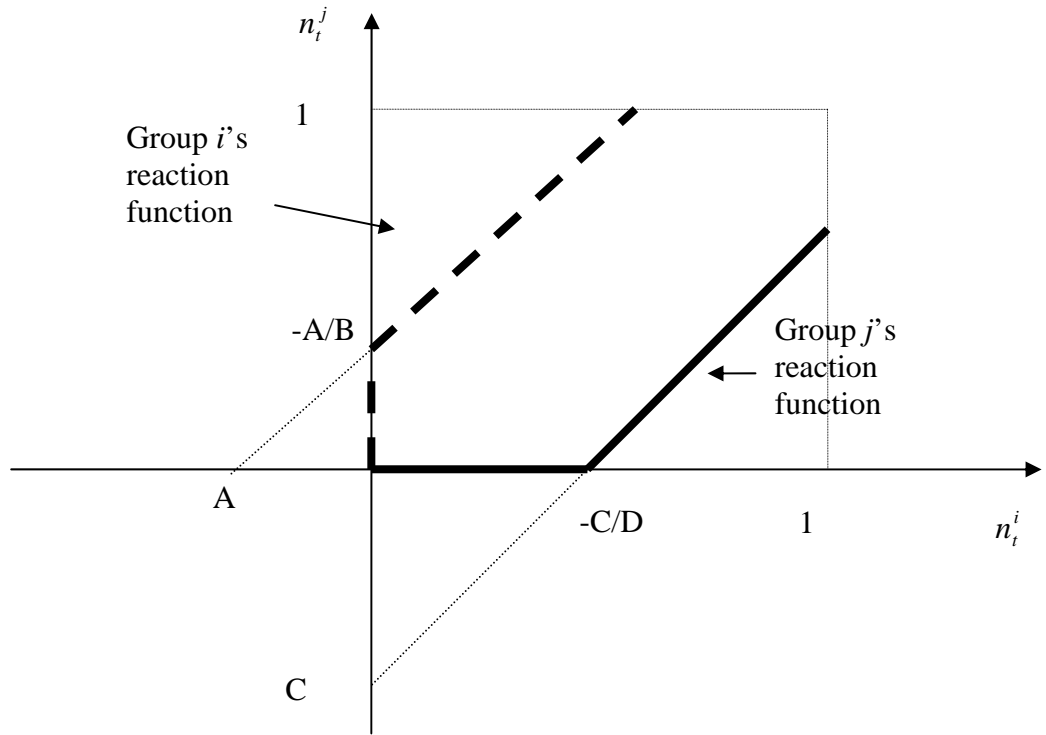


Figure 1: Reaction functions of both groups under low inequality where $A < 0$ and $B > 0$.

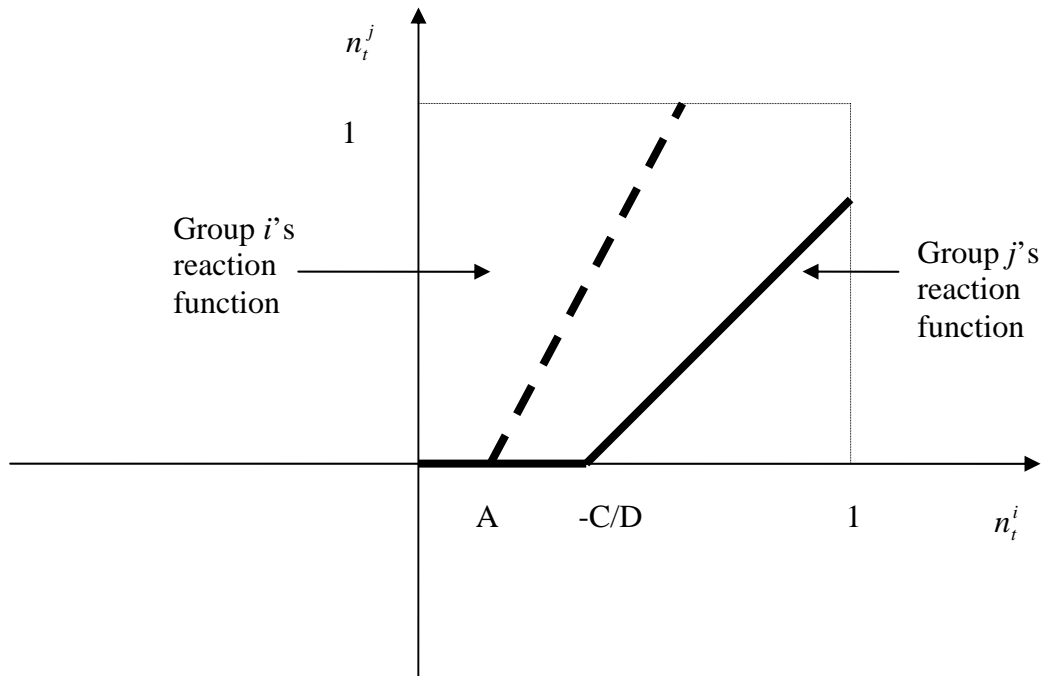


Figure 2: Reaction functions of both groups under medium inequality where $A > 0$ and $B > 0$.

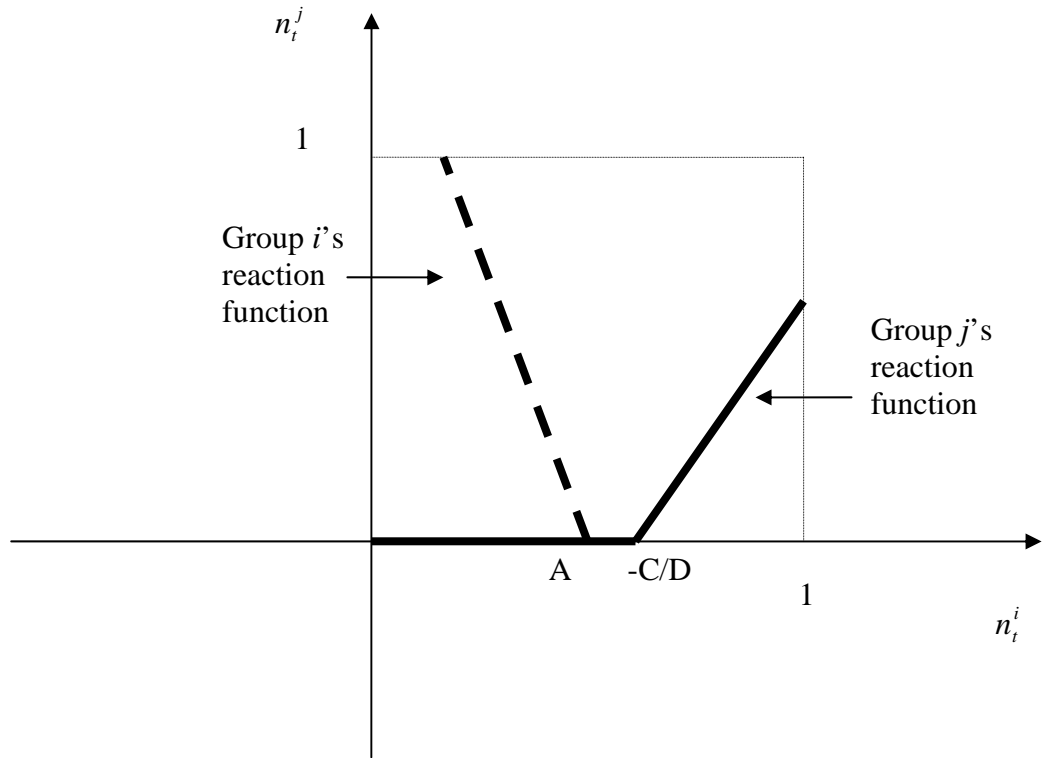


Figure 3: Equilibrium under medium inequality where group i 's reaction function has a negative slope ($B < 0$).

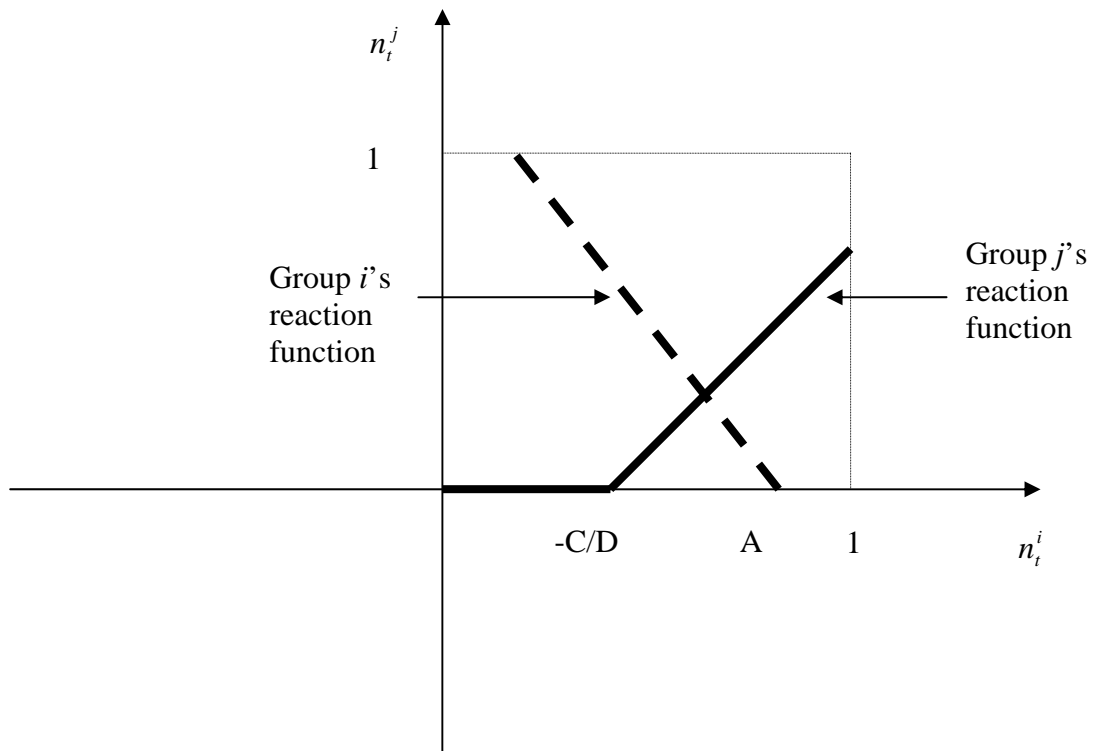


Figure 4: Pure strategy equilibrium under high anticipated inequality.

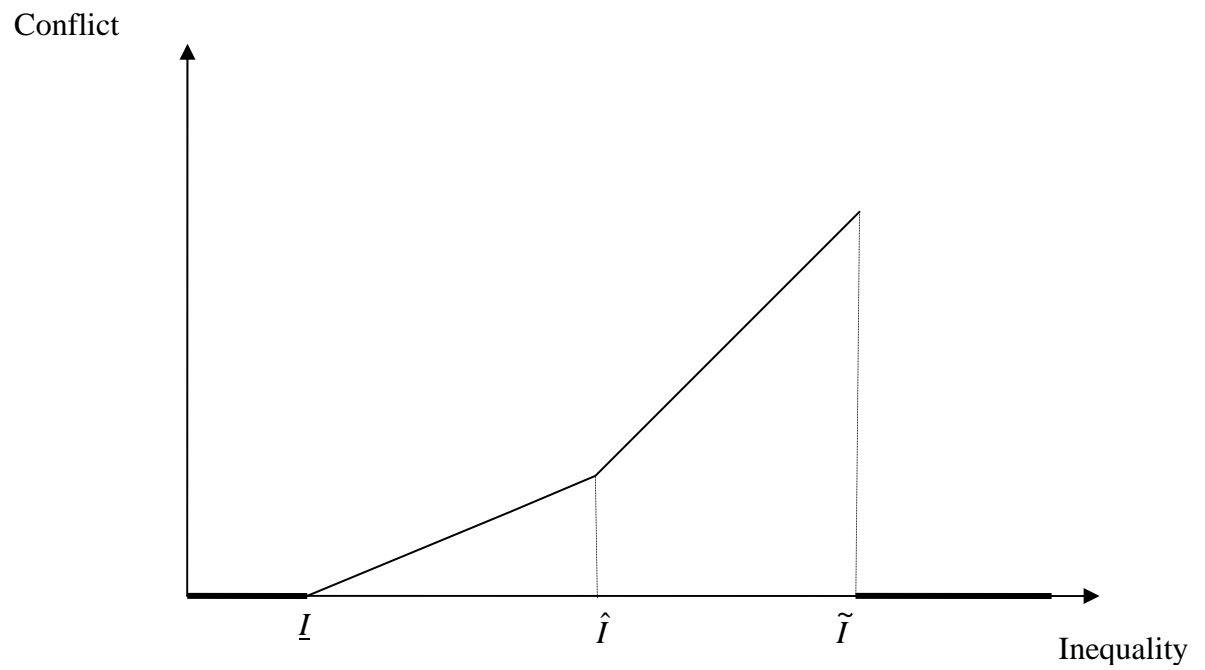


Figure 5: Link between inequality and conflict under the additive aggregation rule.